PLANT ITEM MATERIAL SELECTION DATA SHEET

R10344403

RLD-VSL-00008 (HLW)

Plant Wash and Drains Vessel

- Design Temperature (°F)(Max/min): 165/40
- Design Pressure (psig) (Max/min): 15/FV
- Location: incell
- PJM Discharge Velocity (fps): 26
- Drive Cycle: 25 %

Offspring items

RLD-VSL-00016A/B, RLD-RFD-00163A/B
RLD-PJM-00001 -- RLD-PJM-00004

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 6 and 7

ISSUED BY RPP-WTP PDC
INIT DATE

Operating Modes Considered:

- The vessel is always alkaline, pH 10, at the normal operating temperature.
- Acid from canister decontamination is present without neutralization and halide concentrations are small.
- NaOH is present without neutralization.
- The vessel is filled with process water with only small quantities of other chemicals.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)
Steam ejectors and piping: UNS N06022

The vessel head on the inside of the vessel under nozzles 21, 22, 23, and 24 shall have a band of Hastelloy C-276 clad layer a minimum of 4 inch wide surrounding the outer perimeter of the nozzle pipe.

Recommended Corrosion Allowance: 0.04 inch (includes 0.00 inch erosion allowance; localized protection is provided as necessary and is discussed elsewhere)

Process & Operations Limitations:

- Develop rinsing/flushing procedure.
- Develop lay-up strategy.

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This bound document contains a total of 7 sheets.

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Corrosion Considerations:

Vessel collects all vessel, sump, and plant washes from C3 and C5 areas within the HLW vitrification as well as wash water from cell walls, equipment exterior surfaces, stainless steel cladding, and bulges. Sodium hydroxide is added to adjust pH as necessary.

a General Corrosion
Hamner (1981) lists the corrosion rate for 304 (and 304L) in NaOH to be less than about 20 mpy at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Sedriks (1996) states that the 300 series are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Indications are that in pH 8 water, the uniform corrosion rate is negligible even at the design temperature.

The only concern is that if the vessel can actually receive un-neutralized canister decontamination solutions, then it will depend on how long they are present. If excess decontamination acid is present, the fluoride concentration is expected to be small and the excessive HNO_3/HF corrosion rates are not expected. Excess Ce^{IV} may be present in acid but this is not expected to be a concern.

Conclusion:
304L or 316L is acceptable for normal operating conditions.

b Pitting Corrosion
It is thought that in alkaline solution chlorides are likely to promote pitting only in tight crevices. Koch (1995) is of the opinion that fluoride will have little effect in an alkaline media.

Normally the vessel is to operate at 86°F. This acceptable for 316L as long as there is no concentration of neutralized solutions.
No significant concentrations of pitting agents are expected, particularly considering the concentration of nitrate. 316L is recommended.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, and is likely because residual chlorides are likely to remain.

Conclusion:
Localized corrosion, such as pitting, is common but is not expected to be a concern under the given conditions. 316L is considered acceptable.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in hot concentrated acid conditions.

Conclusion:
Not believed likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Further, as seen in Sedriks (1996) and Davis (1987), stress corrosion cracking does not usually occur below about 140°F.

Steam ejectors will be used to empty the vessel. A band of C-276 is needed in the high temperature zone of the dome to prevent cracking at the nozzle entry.

Conclusion:
Because of the normal operating environment as well as that which can occur during off normal conditions, 316L is recommended. The steam ejector should be Hastelloy C-22 or equivalent.

e Crevice Corrosion
Solids content could lead to deposits on the bottom of the vessel. At the normal temperature, 316L will be sufficiently resistant to crevice corrosion. In addition, see Pitting.

Conclusion:
Under the stated operating conditions, 316L appears satisfactory.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

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g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are conducive to microbial growth though in this part of the system microbial contaminants are not expected.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Corrosion fatigue is a not expected to be a problem.

Conclusions
Not expected to be a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether this will be sufficiently washed or whether residual acids or solids will be present. In the former case, 304L would be satisfactory. If particles or droplets remain on the surface, concentration of the salts is feasible and could lead to pitting. 316L is the minimum recommended.

Conclusion:
Not expected to be a concern, although 316L should be used.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. At least 0.051 inch of additional 316L stainless steel should be provided as localized protection for the applicable portions of the bottom head *to accommodate PJM discharge velocities of up to 8.9 m/s with solids concentrations of 26 wt% for 10 % of the time and 0.029% for 90 %* of the time during 100 % operation. A maximum solids concentration of 26-wt% occurs during non-routine operations using contract maximums in the leach case.

The wear of the PJM nozzles can occur from flow for both the discharge and reflood cycles of operation. At least 0.040 inch of additional 316L stainless steel should be provided on the inner surface of the PJM nozzle to accommodate wear due to PJM discharge and suction velocities with solids concentrations up to 26 wt% for 10 % of the time and 0.029 % for 90 % of the time during 100 % operation.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel walls. Additional localized protection for the bottom head will accommodate PJM discharge velocities and for the PJM nozzles will accommodate PJM discharge and reflood velocities.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
For passive alloys there is negligible potential difference so galvanic corrosion is not a concern.

Conclusion:
Not expected to be a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

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p Inadvertent Nitric Acid Addition

Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:

The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid.

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References:

1. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
2. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
3. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
4. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
5. Smith, HD and MR Elmore, 1992, *Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW)*, PNL-7816, Pacific Northwest Laboratory, Richland, Washington.

Bibliography:

1. Agarwal, DC, *Nickel and Nickel alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
2. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
3. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
4. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

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OPERATING CONDITIONS

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Plant wash and drains vessel (RLD-VSL-00008)

Facility HLW

In Black Cell? Yes

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	1.23E-02		1.71E+01	5.31E+01	
Chloride	g/l	2.55E-04		5.29E-01	7.42E-01	
Fluoride	g/l	1.65E-04		6.30E-01	7.51E-01	
Iron	g/l	1.34E-01	1.43E-04	1.88E+02	1.27E+02	
Nitrate	g/l	2.56E-02	2.65E-02	3.15E+01	3.40E+01	
Nitrite	g/l	8.24E-04		2.92E+00	3.39E+00	
Phosphate	g/l	2.31E-03		4.34E+00	1.33E+01	
Sulfate	g/l	4.11E-04		1.13E+00	1.36E+00	
Mercury	g/l	9.33E-04		2.72E+00	3.12E+00	
Carbonate	g/l	2.27E-03		4.02E+00	5.03E+00	
Undissolved solids	wt %	0.029%		26%	23%	
Other (NaMnO4, Pb,...)	g/l	4.93E-03		6.91E+00	4.69E+00	
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Tmin 59 °F, Tnorm 86 °F, Tmax140 °F
3. pH 8 to 12.6; Average pH 10

Assumptions

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5.6.6 Plant Wash and Drains Vessel (RLD-VSL-00008)

Routine Operations

The plant wash and drains vessel (RLD-VSL-00008) is in a black cell and collects all vessel, sump, and plant washes from C3 and C5 areas within the HLW vitrification building. Vessel RLD-VSL-00008 also collects wash water from cell walls, equipment exterior surfaces, stainless steel cladding, and bulges. These effluents enter RLD-VSL-00008 via wash effluent breakpots RLD-BRKPT-00001 and RLD-BRKPT-00003. The PJMs keep the vessel contents well mixed for a representative sample. Sodium hydroxide is added to the vessel based on the sample analysis and the mass of effluent in the vessel. The vessel receives intermittent flows, and transfers to pretreatment vessel PWD-VSL-00043 when the batch is full or at the operator's discretion.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.